

Estimation of Stature from Length of Thumb in Salem Population

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Abstract

Personal identification plays an integral part of any investigation in medico-legal cases. Stature is one of the important parameter. When the body is disintegrated or mutilated, estimation of stature becomes very difficult. There are many studies where stature is estimated using hand and foot length, length of middle finger, length of index and ring finger. But, there are very few studies where length of thumb has been used to estimate the stature. And most of the studies were applicable to adolescent population only. Hence the present study was planned to estimate the stature of the person using length of thumb of both the hands and identify the degree of its reliability for identifying a person. The present study was conducted in 200 subjects, 96 males and 104 females. The mean age of male subjects is 42.16 years and of female is 38.06 years. Mean length of left thumb (7.15 cm) and right thumb (7.08 cm) length in male is significantly more than that of females (6.45 cm) & (6.37 cm). We observed a significant correlation between thumb length and stature (right thumb $r=0.520$ and left thumb $r=0.559$) and the significant level for both pair is ($p<.0001$).

Keywords: Forensic; Identification; Stature; Thumb Length.

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Introduction

Personal identification plays an integral part of any investigation in medico-legal cases. In this, stature is one of the most important and useful anthropometric parameter that determines person's identity [1]. Since early times, when the

body is skeletonised, stature is estimation using long bones. Many factors like racial, ethnic and nutritional factors play an important role for development and growth of human being affecting the stature in different population [2].

Fixing the identity of a person especially in case of mass disasters or natural calamities like floods, hurricanes, earth-quake, tsunami, or in cases of explosion, plane crash, etc is very difficult. Even more difficulties are faced when body is disintegrated or burnt [1-3]. Hence, there is need to explore newer parameters and establish newer methods to estimate the stature of a person.

There are many studies where stature is estimated using hand and foot length, length of middle finger, length of index and ring finger [4-7]. But there are very few studies where length of thumb has been used to estimate the stature [8]. Hence the present study is planned to estimate the stature of the person using length of thumb of both the hands and identify the degree of its reliability for identifying a person.

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Aims

1. To find out the correlation between the length of the thumb and the stature of the person.
2. To identify the degree of its reliability for estimating the stature of a person.

Materials and Methods

This cross-sectional study done at Annapoorna Medical College & Hospital, Salem, Tamil nadu comprised of 200 subjects including 96 males and 104 females. We have included subjects between 18 yrs to 60 yrs of age of both the sexes and excluded subjects having spine and limb deformities-scoliosis, kyphosis, arthritis, missing thumb etc and also pregnant women. All the samples were collected from Salem district, Tamilnadu.

Measurements

Informed written consent was taken from the subject before taking the measurements.

Height of the person: Individual height (in cm) was measured as vertical distance from the vertex to the heel making the participant stand erect on a platform of stadiometer with bare foot and the shoulder blocks and buttocks touching the wall, Palms of hand turned inwards and fingers horizontally pointing downward.

Length of the thumb

The length (in cm) of the thumb- was measured with the help of Sliding Digital Callipers. The distance from the midpoint of proximal flexor

crease till the tip of the thumb when the subject's hand was placed supine on a flat horizontal surface with the fingers stretched and extended is taken as the length of the thumb.

The measurement was repeated thrice and the average of the three was taken as the final reading.

The obtained data was entered into Microsoft excel and SPSS Version 23.0. Interpretation was done using appropriate statistical methods, by formulating regression equation to estimate the stature from length of the thumb.

Results

In this study, data was collected from 200 subjects. Among them 96 are males and 104 are females. The mean age of male subjects is 42.16 years and of female is 38.06 years. The stature was measured for the subjects and compared for any gender difference. The mean height of male subjects (165.62 cms) is more than that of female subjects (154.00 cms). The difference in mean height of male and female is statistically significant ($p < 0.0005$). Mean length of left thumb (7.15 cm) and length of right thumb (7.08 cm) in male is significantly more than that of females (6.45 cm) & (6.374 cm)(Table 1).

In the present study, we observed a significant correlation between length of thumb and stature (right thumb $r = 0.520$ and left thumb $r = 0.559$) and the significant level for both pair is ($p < .0001$). Amongst male, the correlation is little higher between length of left thumb and height, where as in females, correlation is higher between length of right thumb length and height (right thumb $r = 0.452$ and left thumb $r = 0.432$) (Table 2).

Table 1: Group Statistics

| | Descriptive Statistics | | | | |
|-----------------------------|------------------------|-----|---------|----------------|-----------------|
| | SEX | N | Mean | Std. Deviation | Std. Error Mean |
| Age | Male | 96 | 42.156 | 13.1832 | 1.3455 |
| | Female | 104 | 38.058 | 13.4271 | 1.3166 |
| Length of Right Thumb (LRT) | Male | 96 | 7.150 | .4933 | .0503 |
| | Female | 104 | 6.451 | .5055 | .0496 |
| Length of Left Thumb (LLT) | Male | 96 | 7.080 | .4721 | .0482 |
| | Female | 104 | 6.374 | .4831 | .0474 |
| Height | Male | 96 | 165.620 | 6.4030 | .6535 |
| | Female | 104 | 154.000 | 7.2968 | .7155 |

Table 2: Pearson Correlation (r) between Thumb length and Stature (in cms)

| Parameter | Male | Significance | Female | Significance |
|-----------|-------|--------------|--------|--------------|
| LRT | 0.520 | $P < 0.0001$ | 0.452 | $p < 0.0001$ |
| LLT | 0.559 | $P < 0.0001$ | 0.432 | $p < 0.0001$ |

Table 3: Student 't' test results showing the significance of the difference between male and female.

| Parameter | t | df | Sig. (2-tailed) |
|-----------|--------|-----|-----------------|
| Age | 2.176 | 198 | .031 |
| LRT | 9.884 | 198 | .000 |
| LLT | 10.441 | 198 | .000 |
| Height | 11.929 | 198 | .000 |

Table 4: Linear Regression Models Calculated to Reconstruct the Stature from Thumb (in cms)

| Parameter | Male stature | Female stature |
|-----------------------------|-----------------------|-----------------------|
| Length of Right Thumb (LRT) | 117.384 + 6.749 × LRT | 111.929 + 6.522 × LRT |
| Length of Left Thumb (LLT) | 111.972 + 7.577 × LLT | 112.412 + 6.525 × LLT |

Table 5: Predictive accuracy for the Regression Equation Derived

| | Parameter | R | R-Square | Adjusted R-Square | S.E.E (cm) |
|--------|-----------|------|----------|-------------------|------------|
| Male | LRT | .520 | .270 | .262 | 5.4991 |
| | LLT | .559 | .312 | .305 | 5.3388 |
| Female | LRT | .452 | .204 | .196 | 6.5414 |
| | LLT | .432 | .187 | .179 | 6.6130 |

The descriptive statistics for Age, Length of left thumb (LLT), Length of Right Thumb (LRT) and height are compared by using Student 't' test. As the calculated positive values are more than 1.96 (Table 3) we concluded that, the difference between male and female subjects are statistically significant.

By applying regression equation,

$Y=c+ax$, where 'Y' is dependent variable, 'x' is independent variable, 'a' is coefficient and 'c' is constant. In our study, the dependent variable 'Y' is height and the independent variable 'x' is thumb length. The equations for reconstructing the stature of males and females using left and right thumb lengths were derived (Table 4).

As the ANOVA results show that the prediction of the dependent variable using Left and Right thumb for both sex are statistically significant (p-value <0.05). The regression model equations obtained are valid for estimations of height for a given value of thumb measurement.

The predictive accuracy for regression models for stature reconstruction was also derived. In females, 'R' for LLT is 0.432 and for LRT is 0.452. For males, 'R' for LLT is 0.559 and for LRT is 0.520. (Table 5).

Discussion

Stature reconstruction from skeletal remains is one of the most important anthropological analyses for the purpose of identification of a person. Stature is usually estimated by the anatomical and mathematical method [9]. Anatomical method

can be used when all the bones i.e, from skull to calcaneum is available. But in cases where only some body parts are available, it is difficult to apply. In such cases, mathematical method i.e., based on the relationship between length of long bones and stature can be applied, by utilizing ratios or regression analysis. Though it is less precise, it is workable even if a fragment of long bone is available [10]. Stature of a person depends on various factors like nutrition, genetic diversity, geographical location, hormonal, etc.

Estimation of stature by Regression formulae varies from population to population and it is sex specific. Hence, Regression formulae obtained for a specific population cannot be applied for others, it may either underestimate or over estimate [1,11].

There are many studies where stature is estimated using hand and foot length, length of middle finger, length of index and ring finger [4-7]. There are very few studies where length of thumb has been used to estimate the stature [8]. And most of the studies were applicable to adolescent population only. Hence there is need to study the correlation of stature and length of thumb in different geographical location which could be applied to adult population.

Raju et al. studied 250 subjects of age 18-25 years from Davangere district, Karnataka and found that right index finger was best prediction of stature in females and right ring finger in case of males. It was also found that, better prediction of stature from finger lengths could be done in males when compared to females [12].

Tyagi et al. studied subjects from Delhi and also found that index finger was best predictor of stature in both males and females [2].

Khan et al. studied relationship of stature and middle finger among 150 students of 17-22 yrs age group in Mangalore university and found a very good correlation with a coefficient of 0.658 and p value of <0.001 which is highly significant [13].

Rastogi et al. estimated stature from middle finger length and found positive correlation that ranged from 0.504 to 0.696 while studying the north and south Indian population [6].

Habib et al. studied 159 Egyptians of age 18-25 years and found that little finger in males and distal phalanges of females fingers were not correlated with stature [14].

In our study, we observed a significant correlation between stature and length of both the thumbs (right thumb $r=0.520$ and left thumb $r=0.559$) and the significance level for both pair is ($p<.0001$). Amongst male, correlation is little higher between length of left thumb (LLT) and height, where as in females, correlation is higher between length of right thumb length (LRT) and height (right thumb $r=0.452$ and left thumb $r=0.432$). Kumar et al. also found a positive correlation between Length of thumb and stature. The correlation coefficient ranged from 0.240 to 0.256. [15] In a study done by Prerna et al. the correlation coefficient of right thumb was 0.635 and left thumb 0.245 in males and in females it was 0.212 for right thumb and 0.197 for left thumb [16].

In our study, Anova results also showed that the prediction of the dependent variable using Left and Right thumb for both sex are statistically significant. And the regression model equations obtained are valid for estimations of height for a given value of thumb measurement. The predictive accuracy for regression models for stature reconstruction i.e., 'R' for LLT is 0.432 and for LRT is 0.452 in females and 'R' for LLT is 0.559 and for LRT is 0.520 for males.

Conclusion

When Forensic Investigators receive a disintegrated body or skeletal remains, establishing the identity of the person is really challenging. Stature is one of the important criteria to fix identity of a person. In the present study, we observed a significant correlation between stature and length of both the thumbs. And the regression model equations obtained are valid for estimations of height for a given value of thumb measurement.

So, even if only thumb is available it is possible to estimate the stature of individual using regression model equations. Further studies have to be carried out in different geographical locations and with a bigger sample size to find out the reliability of regression model equations in their locations.

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